or evaluated between the points where $\nu_{\parallel}$ reduces to zero for "locked" particles.. The line of integration is described using coordinates x and ρ, defined as:

$$r = R; \; x = r - R, \; \rho = \sqrt{x^2 + z^2}, \; x = \rho \cos \varphi$$

on some fixed cross-section Θ = const (see Fig. 1). Using conservation of modulus of velocity vector and introducing transverse adiabatic invariant $J_{\perp} = \nu_{\perp}^2/H$, the authors rewrite Eq. (1) in the form:

$$J_{\parallel}(\rho, x, J_{\perp}) = \oint \sqrt{v^2 - J_{\perp} H}\, dl. \tag{2}$$

Equation $J_{\parallel}(\rho, x, J_{\perp})$ = const. represents the equation of the magnetic surface along which the

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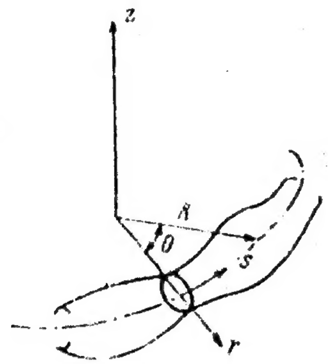

Fig. 1.

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particle is moving. If Θ - constant section is taken across a maximum (or minimum) of the field or

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axis r = R, displacement of the particle during a period is determined from equations of Kadomtsev

$$\Delta\varphi = \frac{mc}{eH_\rho}\frac{\partial J_\parallel}{\partial\rho}, \quad \Delta\rho = -\frac{mc}{eH_\rho}\frac{\partial J_\parallel}{\partial\varphi}, \quad (3)$$

where $H(\rho, \varphi)$ = field strength in section. Particles for which $\Delta\varphi$ = 0 the authors call resonant particles. In general, it is difficult to discover conditions that have to be satisfied by the field, which would ensure trajectories defined by equation:

$$J_\parallel\left(\rho, \frac{x}{R}, J_\perp\right) = \text{const} . \quad (4)$$

correspond to an absolute trap. The authors, therefore, limit themselves to the case when R is finite but sufficiently large. They prove for $R \longrightarrow \infty$ trajectories of particles differ by an arbitrarily small

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quantity from circle $\rho = \rho_o$, whenever $\xi = x/R$ varies between the limits $(\xi_\alpha \approx -\rho_o/R) < \xi < (\xi_\omega \approx \rho_o/R)$ by proving the following mathematical theorem: All points of an arbitrary continuous segment of curve

$$J(\rho, \xi) = J(\rho_o, \xi_o), \quad (7)$$

containing point (ρ_o, ξ_o) and lying inside strip $-a < \xi_\alpha \leqslant \xi \leqslant \xi_\omega < a$ are arbitrarily close to point $(\rho_o \xi_o)$ if ξ_α and $\xi_\omega \longrightarrow 0$. This constitutes proof that in the region where the longitudinal invariant holds, crimped toroidal magnetic field represents an absolute trap for a sufficiently large R. The authors show next that field with $\partial J_{||}/\partial \xi$

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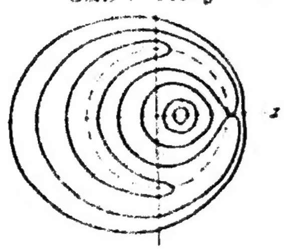
finite and with $\partial J_{11}/\partial \xi \rightarrow \infty$ leads to equation of motion similar in structure. Next they show in the case of $\partial J_{11}/\partial \rho \neq 0$ the displacement of the particle during bending of the field is proportional to 1/R, while for the resonant case where $\partial J_{11}/\partial \rho = 0$ and with $\partial^2 J_{11}/\partial \rho^2 = 0$ it is proportional to $1/R^{1/2}$. In the former case trajectories have then the shape of displaced circles, while in the latter case they have the form of horseshoes as on Fig. 4.



Card 7/10 Fig. 4.

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Turning their attentions to weakly crimped field, the authors start from a scalar potential of such a field:

$$\psi = H_0 s - \frac{h}{\alpha} \sin \alpha s I_0(\alpha\rho),$$

where

$$s = R\varphi,\ \rho^2 = x^2 + z^2,\ x = r - R.$$

and potential is valid for $R \gg L$ and $h \ll H_0$. They discuss in detail trajectories of "locked in" and "flying through" particles. To compare these results obtained from $J_{\parallel}$ = const equation, the authors finally investigate motion of particles from the standpoint of drift equations. They show modulus of departure of solutions for the curved case from

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solutions for $R = \infty$ case is bounded except in the case of resonances. They compute drift angle $\Delta\varphi_T$ per period for the straight case, assuming it to be (in the approximation used) the same as that of the curved field. To estimate validity of the longitudinal invariant approach, they compare drift equations with equations (3). They find ratio of accuracy of drift equations and equations (3) by Kadomtsev are of the order of $\nu T/L$. Except for a small group of very slow particles with large T, whose velocity range is exponentially small:

$$\frac{\Delta v}{v} \sim l^{-\frac{vT}{L}},$$

the majority of particles have $\nu T/L \sim 1$, and discrepancy between the theories is small. The authors also conclude only resonant particles with $\Delta\varphi_T = 2m\pi$

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can escape from the trap. They note since equation $J_{\parallel}$ = const is valid during a longer period of time than drift equations, one can expect $J_{\parallel}$ to be conserved longer than Kadomtsev Equations (3) from which it is deduced. Academicians M. A. Leontovich and L. A. Artsimovich appraised and discussed the problem. There are 5 figures; and 7 references, 4 Soviet, 3 U.S. The U.S. references are: L. Spitzer. The Stellarator Program. Report at the Geneva Conference, 1958. N. Wentzel. Astr. J., 126, Nr 3, 559, 1957, M. Rosenbluth, C. Longmire. Ann. of Phys., 1, 120, 1957.

ASSOCITION: None given.

SUBMITTED: May 26, 1959

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9.3150, 24.2120, 16.7600

77830
SOV/57-30-3-4/15

AUTHORS: Morozov, A. I., Solov'yev, L. S.

TITLE: Motion of Particles in a Screwed Toroidal Magnetic Field

PERIODICAL: Zhurnal tekhnicheskoy fiziki, 1960, Vol 30, Nr 3, pp 271-282 (USSR)

ABSTRACT: The authors generalized the longitudinal invariant of the screwed field bent into a torus and used it to investigate the motion of particles in such a field. They started by a thorough exposition of the structure of the screwed field previously discussed in part by Spitzer, Johnson, et al. (see refs). The field with the screwed symmetry $H = H(r, \varphi - \alpha z)$ can be represented by means of a scalar potential:

$$\psi = H_0 z + \frac{1}{\alpha} \sum_{1}^{\infty} h_n f_n(r) \sin n\Theta, \quad \Theta = \varphi - \alpha z, \tag{1}$$

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where $f_n(r) = I_n(\alpha nr)$, $\alpha = 2\pi/L$; L = pitch of the screw; or, by means of a vector potential:

$$A_\varphi = H_0\frac{r}{2};\ A_z = r\sum_1^\infty h_n f_n(r)\sin n\Theta,\ A_r = -\frac{r}{\alpha}\sum_1^\infty \frac{h_n}{n} f'_n(r)\cos n\Theta. \qquad (2)$$

Using the averaging method of Bogolyubov (N. N. Bogolyubov, Yu. A. Metropol'skiy, Asimptoticheskiye metody v teorii nelineynkh kolebaniy (Asymptotic Methods in the Theory of Nonlinear Oscillations) GITTL, M., 1955), they obtain equations for the magnetic field lines and discuss also the exact solutions for the field lines. These lines may be divided into two classes separated by a surface "separatrix": (1) collective lines remaining inside a certain cylinder; (2) isolated lines leaving that region. The section of the separating surface with phase z = const has the form of a rosette. Figure 2 shows such a rosette "separatrix" for n = 3. In space the separatrix represents an n-gonal

screwed surface with a pitch L. In addition to obtaining the equation of the separatrix, the authors derive also the general expression for the phase shift:

$$\Delta\varphi = -\frac{\pi h^4}{2 i^4 H_0^4 n}\left\{\frac{1}{r}\frac{d}{dr}\right\}^2\left[f_n^2 + \frac{h^2}{4 i^4 H_0^2 n^2}\frac{1}{r}\frac{d}{dr}\left(r f_n f_n'\right)\right].$$

exact to terms in h^2/H_0^2. Next they derive the expression for the longitudinal invariant in the case of "locked in" particles:

$$J_{\parallel}(r_0, \vartheta_0) = \text{const.} \qquad (12)$$

and show that in the case of "flying through" particles, the pertinent equation is given by:

$$W = \Omega - J_{\parallel} = \frac{2\pi e}{mc}\int H \sqrt{\frac{g}{g_{33}}}\,\omega(r)\,dr - J_{\parallel} = \text{const.} \qquad (19)$$

where $\omega = \bar{\alpha}\lambda/2\pi$; $\bar{\alpha}$ is some initial value of α, and $\lambda = L/n$ is pitch of the magnetic field line of a particular harmonic. The authors extend automatically to the present case the proof for the absolute character of the trap (derived in the preceding article

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(A. I. Morozov, L. S. Solov'yev, ZhTF, XXX, 261, 1960) for the caseof a corrugated field) by conserving either $J_{\parallel}$ or W. A special feature of the screwed field motion is the absence of "locked-in" particles from the axis of the field. This may be explained by the fact that the alternating component vanishes as one approaches the axis. The authors also note that in the present field there exists a resonance only for particles moving against the field ($H\bar{v} < 0$). Again, ,as in the corrugated field case, excluding the small number of particles for which $v\, T/L \gg 1$, one can claim that in the limits of the longitudinal invariant the screwed toroidal magnetic field represents an absolute trap in the region inside the separatrix. The authors next investigate the motion of particles in fields with a strong longitudinal component bent into a torus of a sufficiently large R, so that one can neglect quantities of the order of $1/R^2$:

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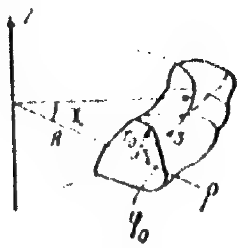

Fig. 4.

They limit themselves also to fields whose scalar potential contains only the first harmonic. They compute $J_{||}$ for the "locked-in" particles and show that in the neighborhood of the resonance, the particle does not complete the path around the axis of the torus but follows some horseshoe-like curve. The "flying-through" particles are discussed using the W invariant, and the authors in particular evaluate the amount by which the circular motion in the meridional planes of the torus is displaced from the axis r = 0. Finally, the authors discuss the

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and gave advice. There are 4 figures; and 6 references, 4 Soviet, 2 U.S. The U.S. references are: L. Spitzer, The Stellarator Program, Report at Geneva Conference, 1958; J. Johnson et al., Some Stable Hydromagnetic Equilibria, Report at Geneva Conference, 1958.

SUBMITTED: May 26, 1959

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84451

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26.2331

AUTHORS: Morozov, A. I. and Solov'yev, L. S.

TITLE: The Acceleration of Plasma in the Coaxial

PERIODICAL: Zhurnal tekhnicheskoy fiziki, 1960, Vol. 30, No. 9, pp. 1104-1108

TEXT: In the first part of the present paper, the authors investigate the equilibrium of an accelerated plasma, assuming acceleration to occur in a coaxial device with an azimuthal magnetic field. The equation of equilibrium $-\nabla(p + H^2/8\pi) + (1/4\pi)(\vec{H}\nabla)\vec{H} + \rho\vec{a} = 0$ (1) is written down, and on the assumption of isothermal conditions the equation $2c_T^2\partial h/\partial z + a\partial/r\partial r\,(r^2h) = 0$ (5) is obtained from (1) in cylindrical coordinates. Here, $h = H^2/8\pi$, and c_T is the sonic velocity in the plasma. (5) has the general solution $h = (\Phi/r^2)(z - \frac{1}{a}2c_T^2\ln r)$ (6). Further,

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qualitative consideration. They obtain approximate expressions for the layer on the walls of the coaxial device, and find that this layer has small thickness if the particle concentration in the plasma cluster is higher than 10^{18} - 10^{19}. Finally, the authors thank Academician L. A. Artsimovich for his interest and advice. There are 4 figures and 3 Soviet references.

SUBMITTED: April 8, 1960

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S/057/61/031/004/004/018
B125/B205

AUTHOR: Solov'yev, L. S.

TITLE: Magnetohydrodynamic surface waves

PERIODICAL: Zhurnal tekhnicheskoy fiziki, v. 31, no. 4, 1961, 407-418

TEXT: The present paper deals with non-linear surface waves of an ideally conducting plasma in the presence of an external magnetic field. The relation div $\vec{v} = 0$, curl $\vec{v} = 0$ holds for both the potential flow of an incompressible liquid and the external magnetic field. The internal magnetic field is considered to be non-existent. Substitution of the functions Ψ and Ψ_o gives $H_x = -\frac{\partial\Psi}{\partial y}$, $H_y = \frac{\partial\Psi}{\partial x}$, $v_x = -\frac{\partial\Psi_o}{\partial y}$, $v_y = \frac{\partial\Psi}{\partial x}$ (1). Ψ and Ψ_o satisfy the Laplace equation $\Delta\Psi = 0$, $\Delta\Psi_o = 0$ (2). If the magnetic field strength is measured in units of the Alfvèn velocity $H = B/\sqrt{4\pi\varrho}$, the following boundary conditions are valid on the surface of the plasma: $(\nabla\Psi)^2 + (\nabla\Psi_o)^2 = \mathrm{const}$ (3) and $\Psi = \mathrm{const}$ and $\Psi_o = \mathrm{const}$ (4). The first section is devoted to separate

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Magnetohydrodynamic surface waves

and after introducing the dimensionless variables

$\frac{y}{d_2} = z$, $\frac{x}{d_2} = \xi$, $\frac{d_1}{d_2} = \alpha$, $\frac{v_0}{H_0} = \beta$ it follows that (10) with

$$\left(\frac{dz}{d\xi}\right)^2 = \frac{4k^2 z_1}{z_m} z^2 \frac{z - z_m}{z - z_1}, \qquad (10)$$

где

$$k^2 = \frac{3 z_m}{4\alpha} \frac{1}{\alpha - 1 + z_m}, \qquad z_1 = \frac{\alpha^2 - \alpha + (\alpha^2 + \alpha) z_m}{\alpha^2 + 1 + (\alpha^2 - 1) z_m}, \qquad \beta^2 = \frac{\alpha + z_m}{1 - z_m}. \quad (11)$$

(11).

For $\alpha = 1 (d_1 = d_2)$ one has $z_1 = z_m$, and there exists no solution in the form of a separate wave. Then, the integral of (10) reads

$$-\mathrm{ar\,th} \sqrt{\frac{z_1(z - z_m)}{z_m(z - z_1)}} + \sqrt{\frac{z_m}{z_1}}\, \mathrm{ar\,th} \sqrt{\frac{z - z_m}{z - z_1}} = k\xi$$

(12). For $|z_m| \ll |z_1|$ the solution has the form of a single wave on the surface of the heavy fluid. Both running convexities (at $\alpha > 1$) and running concavities (at $\alpha < 1$) may exist in

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the present case. For reasons of symmetry, there is no solution for $d_1 = d_2$. When $d_2 > d_1$, the convexity changes into a concavity. Next, the author studies periodic waves under the same geometrical conditions that are present in the case of separate waves (cf. figure). Here, the steady flow of an incompressible fluid in an external magnetic field is considered. The stream functions satisfying the Laplace equation are set up as series:

$$\left.\begin{aligned} \psi_0 &= v_0 y + (v_1 e^{y} + w_1 e^{-y}) \sin x + (v_2 e^{2y} + w_2 e^{-2y}) \cos 2x + \dots, \\ \psi &= H_0 y + (H_1 e^{y} + h_1 e^{-y}) \sin x + (H_2 e^{2y} + h_2 e^{-2y}) \cos 2x + \dots, \end{aligned}\right\} \quad (14) \qquad (14).$$

By comparing coefficients one finds

$$\begin{aligned} \frac{a_{10}}{v_0} - \frac{a_1}{H_0} &= \frac{3}{8}\left(\frac{a_1^3}{H_0^3} - \frac{a_{10}^3}{v_0^3}\right) + \frac{1}{4}\left(\frac{a_1 b_1^2}{H_0^3} - \frac{a_{10} b_{10}^2}{v_0^3}\right) + \\ &+ \left(\frac{a_1 b_2}{H_0^2} - \frac{a_{10} b_{20}}{v_0^2}\right) + \frac{1}{2}\left(\frac{a_2 b_1}{H_0^2} - \frac{a_{20} b_{10}}{v_0^2}\right), \end{aligned} \quad (15) \qquad (15),$$

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$$-v_0 b_{10} - H_0 b_1 = -\frac{3}{8}\left(\frac{a_1^2 b_1}{H_0} + \frac{a_{10}^2 b_{10}}{v_0}\right) + \frac{3}{2}(a_1 a_2 + a_{10} a_2)_0 - (b_1 b_2 + b_{10} b_{20}),$$

(16),

$$\frac{a_{10} b_{10}}{2v_0^2} + \frac{a_{20}}{v_0} = \frac{a_1 b_1}{2H_0^2} + \frac{a_2}{H_0} - \frac{3a_{10}^2}{4} + \frac{b_{10}^2}{4} - 2v_0 b_{20} = \frac{3a_1^2}{4} - \frac{b_1^2}{4} + 2H_0 b_2, \quad (16)$$

where a_n, a_{no}, b_n, b_{no} indicate the quantities $v_n + w_n = a_{no}$, $v_n - w_n = b_{no}$, $H_n + h_n = a_n$, $H_n - h_n = b_n$, respectively. From the boundary conditions $H_y|_{y=d_2} = 0$, $v_y|_{y=-d_1} = 0$ it follows that $w_n = -v_n e^{-2nd_1}$, $h_n = -H_n e^{2nd_2}$, $a_{no} = b_{no} \,\mathrm{th}\, nd_1$, $a_n = -b_n \,\mathrm{th}\, nd_2$. From the equations of first approximation one obtains the following relation for $\mathrm{th}\, d_i = t_i$:

(17);

$$v_0 = \frac{B_0}{\sqrt{4\pi\rho}} \sqrt{\frac{t_1}{t_2}} \left\{1 + \frac{A^2}{16} \frac{(t_1 + t_2)\left[(3 - t_1 t_2)^2 + 4(t_1 - t_2)^2\right]}{t_1^2 t_2^2 (t_1 - t_2)}\right\}. \quad (17)$$

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Magnetohydrodynamic surface waves

present paper is devoted to waves on the surface of a plasma cylinder rotating about its axis. For the purpose of investigating such waves, the authors apply the general equations for the steady helical flow of an incompressible, ideally conducting fluid in a magnetic field:

(21),
(22),
(23),
(24),
(25).

$$\Delta^*\xi + \frac{aa'}{\beta} + \beta b b' - \frac{2sa}{\beta^2} + u' = 0, \tag{21}$$

$$sa = I_0\psi_0' - I\psi', \quad sb = \frac{1}{\beta}\left(I\psi_0' - I_0\psi'\right), \tag{22}$$

$$p + \frac{v^2}{2} = -s\left(u + \beta b^2\right), \quad \psi_0'^2 - \psi'^2 = s, \tag{23}$$

$$rv_r = \frac{\partial\psi_0}{\partial\theta}, \quad v_\varphi - arv_z = -\frac{\partial\psi_0}{\partial r}, \quad v_z + arv_\varphi = I_0, \tag{24}$$

$$rH_r = \frac{\partial\psi}{\partial\theta}, \quad H_\varphi - arH_z = -\frac{\partial\psi}{\partial r}, \quad H_z + arH_\varphi = I, \tag{25}$$

X

The "internal" and the "external" problem can be exactly calculated, and approximations are used only if these solutions are "fused" at the "seams"

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Magnetohydrodynamic surface waves

between plasma and field. The functions Ψ and Ψ_0 are written as $\Psi = \bar{\Psi} + \tilde{\Psi}$, $\Psi_0 = \bar{\Psi}_0 + \tilde{\Psi}_0$ (26). For the unperturbed state one has $\bar{H}_z = H_{zR}$, $\bar{V}_{zR}$, $\bar{H}_\varphi = H_{\varphi R}\frac{r}{R}$, $\bar{V}_\varphi = V_{\varphi R}\frac{r}{R}$ (27), i.e., a plasma cylinder of radius R, which has a homogeneous longitudinal current and a homogeneous longitudinal magnetic field, will rotate about its axis as a whole. Moreover, the existence of a longitudinal surface current is supposed. The functions Ψ_0, Ψ and I_0, I for the unperturbed state result from (24) and (25). Here and henceforward, the subscript R is omitted. In the present case, Eq. (21) is linear. For the velocity and the magnetic field strength, the following expression is found in cylindrical coordinates:

(34),

$$\left.\begin{aligned} \mathbf{v} &= \left\{\frac{1}{r}\frac{\partial\tilde{\Psi}_0}{\partial\theta},\ \frac{v_\varphi r}{R} + \frac{1}{\beta}\left(\varepsilon a r\tilde{\Psi}_0 - \frac{\partial\tilde{\Psi}_0}{\partial r}\right),\ v_z + \frac{1}{\beta}\left(\varepsilon\tilde{\Psi}_0 + a r\frac{\partial\tilde{\Psi}_0}{\partial r}\right)\right\}, \\ \mathbf{H} &= \left\{\frac{1}{r}\frac{\partial\tilde{\Psi}}{\partial\theta},\ \frac{H_\varphi r}{R} + \frac{1}{\beta}\left(\varepsilon a r\tilde{\Psi} - \frac{\partial\tilde{\Psi}}{\partial r}\right),\ H_z + \frac{1}{\beta}\left(\varepsilon\tilde{\Psi} + a r\frac{\partial\tilde{\Psi}}{\partial r}\right)\right\}. \end{aligned}\right\} \quad (34)$$

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and

$$p+\frac{v^2}{2}=\frac{\varepsilon(J_0v_\varphi-JH_\varphi)}{\alpha RJ}\left\{\phi-\frac{\beta J}{2\alpha^2}\left(\frac{J_0H_\varphi-Jv_\varphi}{J_0v_\varphi-JH_\varphi}\right)^2\right\}+\text{const.} \qquad (35)$$

(35)

follows from (23). The boundary condition for the equality of pressures reads

(36).

$$-\frac{v^2}{2}-\frac{\rho\gamma\varepsilon}{2\alpha R}\,\frac{(J_0H_\varphi-Jv_\varphi)^2}{J_0v_\varphi-JH_\varphi}+\frac{H^2}{2}=\frac{H_e^2}{2}+\text{const}, \qquad (36)$$

When formulating the solution to Eq. (21) as $\tilde{\Psi} = f(r)\sin n\Theta$, the expression

$$\frac{1}{r}\frac{d}{dr}\left(\frac{r}{\beta}\frac{df}{dr}\right)+\left(\frac{\varepsilon^2}{\beta}-\frac{2\alpha\varepsilon}{\beta^2}-\frac{n^2}{r^2}\right)f=0. \qquad (38)$$

(38)

is obtained for f(r). The magnetic field outside the plasma column satisfies the equation

$$\Delta^{*}\Psi_e - \frac{2\alpha Ie}{\beta^2} = 0 \quad (39).$$

Magnetohydrodynamic surface waves

For $f_e(r)$ one has $\frac{1}{r}\frac{d}{dr}\left(\frac{r}{\beta}\frac{df_e}{dr}\right) - \frac{n^2}{r^2} f_e = 0$ and

$f_e = A_n r I'_n(\alpha n r) + B_n r K'_n(\alpha n r)$ (47), where I_n and K_n are Bessel functions with imaginary argument. The final expression

$$h_i = \frac{a_1(m-1) + m\varepsilon_1}{k(1+\varepsilon_1^2)} + \frac{\sqrt{(m-1)(1+\varepsilon_1^2)a_1^2 + m\left[1-(m-1)a_1^2\right]\varepsilon_1^2 - (m-1)(a_1^2 - 2a_1 m\varepsilon_1 + m)}}{k(1+\varepsilon_1^2)}, \quad (54)$$

(54)

with $\varepsilon_1 = \frac{H_{ze}}{H_z}$ indicates that the quantity h_1 which is necessary for a stable oscillation, increases owing to the rotation of the column. This may result in an instability. The steady helical flow of an ideally conducting fluid in a magnetic field is calculated in a mathematical appendix. There are 8 Soviet-bloc references.

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Magnetic surfaces

determinant of the coordinate system. The bar denotes the av... the argument x_3. $H^1 = \bar{H}^1 + \hat{H}^1$ is a decomposition into the "... "variable" part of H^1. A linear, a toroidal, and a helical field are ... In the latter case, the magnetic surfaces can be expressed as fu... the mean angle of climb of the lines of force (stellarator). ... types of a linear field are calculated in the second part of ... In doing so, the authors restrict themselves to irrotational ... particular, they calculate the effect of a constant, perpendi... turbation on the stellarator field, the perturbation of the ... corrugated resonance field and a multipole field, and present ... of force. In the general case, n-fold closed rosettes are obta... was established for the first time by I. M. Gel'fand et al. (Ref ...: ZhTF, XXXI, no. 10, p. 1164). Interesting configurations are obtained when considering an irrotational magnetic field which is periodic in x and ... The authors also investigate a generalization of the method ... cases where $\vec{H} = \vec{H}(x_1, x_2, x_3, \varepsilon x_3)$ is a periodic function of both ... and εx_3, ε being a small parameter. This is illustrated by a rota... X

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Magnetic surfaces

If the field is helically symmetric, the magnetic surfaces can be exactly determined in this case. All magnetic surfaces discussed here (rosette, chains and intertwisted tubes) are significant for plasma trapping. If the position of a magnetic surface and the distribution of the lines of force on it are known, it will be possible to construct the adjacent surfaces. At a normal distance w from the given surface, fields with translational symmetry ($\vec{H} = \vec{H}(x,y)$), axial symmetry ($\vec{H} = \vec{H}(r,z)$), and helical symmetry ($\vec{H} = \vec{H}(r,\theta)$) are given by $wH_{\perp}$ = const, $wrH_{\perp}$ = const, and $w\sqrt{1+\alpha^2 r^2} \cdot H_{\perp}$ = const, respectively, where $H_{\perp}$ is the magnetic-field component on the given surface, which is perpendicular to z, to the φ-lines, and to the helical lines $\theta = \varphi - \alpha z$ = const, respectively. I. M. Gel'fand, M. I. Grayev, and M. A. Leontovich are thanked for discussions. There are 10 figures and 6 references: 4 Soviet and 2 non-Soviet. The two references to English-language publications read as follows: Ref. 3: L. Spitzer, The stellarator program, report at the Second Geneva Conference 1958, Ref. 4: J. I. Johnson et al., Second Geneva Conference 1958.

SUBMITTED: November [illegible], 1960

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B111/B112

Magnetic surfaces of a triply twisted ...

i.e., a perturbation of the form $\gamma_{corr} = \frac{h_0}{\alpha} I_0 (k\alpha r) \sin k\alpha z$ (4) on magnetic surfaces at different h_0 and k. Since the total field (1) + (4) is not symmetric, magnetic surfaces can only be calculated numerically. The dependence of the angle of climb of the lines of force on a certain characteristic radius must usually be investigated separately. Calculations are made for $\psi = z + h_3 I_3 (3r) \sin 3 (\varphi - z) + h_0 I_0 (\alpha r) \sin \alpha z$, k = 1 and k = 3, $h_3 = 3$ at different h_0. The interval in which one line of force was considered, was taken as $0 \leq z \leq NL$ (N = 25 and 50, L = 2π). Integration was performed by the Runge-Kutta method with the steps $\frac{2\pi}{40}$, $\frac{2\pi}{80}$, and $\frac{2\pi}{160}$. In particular, the following cases were discussed: 1) α = 1, $h_0 = 0.3$ and 0.6. The magnetic surfaces approach one another with increasing h_0, and tubes not enclosing the z-axis are formed at $h_0 = 0.6$. 2) k = 3, $h_0 = 0.05$, $h_0 = 0.1$, and $h_0 = 0.125$. A periodicity in z with the period $2\pi/3$ was found in these cases. For k = 3, $h_0 = 0.1$ the magnetic surfaces coincide with those obtained at k = 1, $h_0 = 0.6$.

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S/057/61/031/010/002/015
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Inside the fully developed surfaces there occurs a new surface with a three-leafed cross section. This configuration does not rotate but merely vibrates. The magnetic surfaces disappear under the action of strong perturbations, and the points lie on curves with helical cross sections (Fig. 9). The figures indicate the succession of the curve points. There are 10 figures and 5 Soviet references.

SUBMITTED: November 17, 1960

Card 3/5

24705
S/056/61/040/005/005/019
B102/B201

26.2212
24.6750

AUTHORS: Morozov, A. I., Solov'yev, L. S.

TITLE: Kinetic consideration of some equilibrium plasma configurations

PERIODICAL: Zhurnal eksperimental'noy i teoreticheskoy fiziki, v. 40, no. 5, 1961, 1316 - 1324

TEXT: There is a number of plasma systems being of interest in practice, the properties of which cannot be described within the limits of magnetohydrodynamics. Such are, e.g., systems with acute-angled geometry, adiabatic traps with ion injection ("Ogra", "Astron"). Kinetic calculations of equilibrium configurations have been repeatedly performed for special cases. The authors of the present paper offer a kinetic treatment of some concrete one-dimensional plasma configurations. In view of the fact that systems, in which the Larmor radius of both electrons and ions is small compared with the scale of inhomogeneity of the field, can be treated in terms of magnetohydrodynamics, the systems studied here have dimensions of the order of the Larmor radius of electrons or ions. Two limiting cases

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may be distinguished here: in one there is a region of transition of the order of the Larmor radius between the plasma without magnetic field and the magnetic field; in the other, the whole region occupied by the plasma is of the order of the Larmor radius ("Ogra", "Astron"). The authors restrict themselves here to one-dimensional problems, where all quantities are functions of only one coordinate (x), and the equilibrium configuration (neglecting collisions) is given by Vlasov's equations

$$v_x \frac{\partial f_e}{\partial x} - \frac{e}{m}\left(\mathbf{E} + \frac{1}{c}[\mathbf{vH}]\right)\frac{\partial f_e}{\partial \mathbf{v}} = 0,$$

$$v_x \frac{\partial f_i}{\partial x} + \frac{e}{M}\left(\mathbf{E} + \frac{1}{c}[\mathbf{vH}]\right)\frac{\partial f_i}{\partial \mathbf{v}} = 0; \qquad (1a, b)$$

$$\operatorname{div}\mathbf{E} = 4\pi e\int (f_i - f_e)\,d\mathbf{v}, \qquad \operatorname{rot}\mathbf{H} = \frac{4\pi e}{c}\int \mathbf{v}\,(f_i - f_e)\,d\mathbf{v},$$

$$\mathbf{E} = -\nabla\Phi, \qquad \mathbf{H} = \operatorname{rot}\mathbf{A}.$$

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If $H_x = 0$ one obtains

$$\frac{d^2\Phi}{dx^2} = -4\pi e\int (f_i(\mathbf{v}, A, \Phi) - f_e(\mathbf{v}, A, \Phi))\,d\mathbf{v},$$
$$\frac{d^2 A}{dx^2} = -\frac{4\pi e}{c}\int \mathbf{v}\,(f_i(\mathbf{v}, A, \Phi) - f_e(\mathbf{v}, A, \Phi))\,d\mathbf{v}. \qquad (5)$$

or, in axial symmetry ($H_r = 0$)

$$\frac{1}{r}\frac{d}{dr}r\frac{d\Phi}{dr} = -4\pi e\int (f_i - f_e)\,d\mathbf{v},$$
$$\frac{d}{dr}\frac{1}{r}\frac{d}{dr}rA_\varphi = -\frac{4\pi e}{c}\int v_\varphi (f_i - f_e)\,d\mathbf{v}, \qquad (11)$$
$$\frac{1}{r}\frac{d}{dr}r\frac{dA_z}{dr} = -\frac{4\pi e}{c}\int v_z (f_i - f_e)\,d\mathbf{v}.$$

results. The solutions of (5) or (11) are obtained in considerably simpler way by taking the plasma to be quasineutral. The present study begins with

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by introducing dimensionless parameters (this holds for $x<0$). For $Mc^2/T \gg 1$ and $\alpha \ll 1$ one obtains

$$\xi = \ln\left|\operatorname{tg}\frac{\chi}{4} / \operatorname{tg}\frac{\pi}{8}\right| + 2\left(\cos\frac{\chi}{2} - \cos\frac{\pi}{4}\right), \qquad \sin\chi = a. \tag{20}$$

which fits the result by Ferraro (J. Geophys. Res., 57, 15, 1952). The present study is then extended to a plasma screw (Fig. 3), in which the charge is compensated by cold neutrons. This system is described by equations $d^2a/d\xi^2 = a/\sqrt{1-a^2}$; $\gamma = -\frac{1}{2}\ln(1-a^2)$ with the integral $\dot{a}^2 = h_1^2 + 2(1-\sqrt{1-a^2})$, where $h_1 = H_1 eD_{1c}/Mcv_{0i}$, H_1 being the field strength for $x=0$.

$$\xi = -4k^{-1}[E(k) - E(k, \pi/2 - \chi)] + 2(1 + 2/k^2)[K(k) - F(k, \pi/2 - \chi)], \tag{22}$$

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is obtained here for the field change. Finally, the authors examine the interface between plasma and field for ions with a Maxwellian distribution in $x = -\infty$, where the charge is, in turn, compensated by cold electrons.

$$\xi = \sqrt{\frac{2}{\pi}}\int_0^{x} dx\left[1 - \frac{4}{\pi}\int_0^{\infty} \exp\left(-x^2(1+\xi^2)^2/4\right) d\xi \,/\,(1+\xi^2)^2\right]^{-1/2}. \qquad (29)$$

is obtained here. The motion in an axially symmetric field is studied in the following section. A plasma column of monochromatic ions and cold electrons (with Maxwellian distribution) is here considered first ($H_z \neq 0$, all other quantities depend on r only). For $v_{iz} = 0$ the ion trajectories of this system are as shown in Fig. 6a or 6b, depending on whether the Larmor radius is larger or smaller than the column radius. Instead of (11) one has

$$\frac{d}{dr}\left(\frac{1}{r}\frac{d}{dr}rA_\varphi\right) = -\frac{4\pi Q}{cr}\left(\frac{p}{Mr} - \frac{eA_\varphi}{Mc}\right)\left[v_0^2 - \left(\frac{p}{Mr} - \frac{eA_\varphi}{Mc}\right)^2\right]^{-1/2}. \qquad (32)$$

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where Q denotes the radial particle flux, and P is the generalized momentum: $Q = enrv_r = const$; $P = r(Mv_\varphi + eA_\varphi/c) = const$. In dimensionless parameters ($a = eA_\varphi/Mcv_0$, $p = P/Mv_0$) one obtains

$$\frac{d}{dr}\left(\frac{1}{r}\frac{dra}{dr}\right) = -\frac{4\pi eQ}{Mc^3v_0}\frac{p/r-a}{r\sqrt{1-(p/r-a)^2}}. \quad (35)$$

and, with $N = \int_{r_1}^{r_2} n2\pi rdr$

$$N = \frac{2\pi Q}{cv_0}\int_{r_1}^{r_2}\frac{dr}{\sqrt{1-(p/r-a)^2}}. \quad (36)$$

In zeroth approximation $Q = e^2H_0N/2\pi^2Mc$, and

$$H = H_0\left\{1 - \frac{2e^2N}{\pi Mc^2}\arccos\frac{r_1r_2/r+r}{r_1+r_2}\right\}, \quad r_1 < r < r_2. \quad (38)$$

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For a nonrelativistic plasma ($c^2/v_{oe}^2 \gg 1$), $\psi = (1-\mu\theta)a^2/(1+\theta)$ is found, and further,

$$d^2a_1/d\xi_1^2 = a_1/\sqrt{1-a_1^2}, \tag{48}$$

$$a_1 = a\,[(1+\mu)\theta/(1+\theta)]^{1/2}, \quad \xi_1 = \xi\,[1+\sqrt{\mu\theta}]^{1/2}. \tag{49}$$

The thickness of the transition layer is thus found to be $\delta \sim (mc/4\pi e^2 n_0)\left[1+\sqrt{\mu\theta}\right]^{1/2}$. There are 8 figures and 6 references: 4 Soviet-bloc and 2 non-Soviet-bloc. The reference to the English-language publication reads as follows: L. Tonks. Phys. Rev. 118,2, 1960.

SUBMITTED: August 3, 1960

25852

S/020/61/139/004/012/025
B104/B209

24.4100

AUTHORS: Burshteyn, E. L., and Solov'yev, L. S.

TITLE: The Hamiltonian of an averaged motion

PERIODICAL: Akademiya nauk SSSR. Doklady, v. 139, no. 4, 1961, 855-858

TEXT: In solving many physical problems one may use a method of approximation in which averaging of the respective equations and their representation in canonical form leads to their first integral. This study is concerned with a method of obtaining averaged canonical equations. The first section deals with averaging of differential equations of the form

$$\frac{dx_k}{dt} = \varepsilon f_k(x_l, t) \qquad (1)$$

with a small parameter ε, which are periodic functions of t. These systems may be replaced by

$$\frac{d\xi_k}{dt} = \varepsilon\varphi_{1k}(\xi_l) + \varepsilon^2\varphi_{2k}(\xi_l) + \cdots \qquad (2).$$

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where $f_k = f_k(\xi_i, t)$ and η_{ik} are periodic functions of the argument t. The mean value of these functions with respect to t (with constant ξ_i) is defined as $\hat{f} = \int \tilde{f} dt$, where $\tilde{f} = f - \bar{f}$. In the system quoted last, the functions $\bar{\eta}_{ik}$ remain undetermined. The unique definition of φ_{ik} and η_{ik} necessitates the introduction of additional conditions. The simplest of these is the postulate that the η_{ik} vanish. The second section deals with averaging canonical Hamiltonians, with

$$\frac{dq_k}{dt} = \frac{\partial H}{\partial p_k} \equiv \varepsilon f_{qk}, \quad \frac{dp_k}{dt} = -\frac{\partial H}{\partial q_k} \equiv \varepsilon f_{pk}, \qquad (6)$$

taken as a starting point. When η_{ik} is properly chosen, (2) may assume the Hamiltonian form. For the determination of $\bar{\eta}_{ik}$, the canonical transformation

$q_i = \frac{\partial}{\partial q_i} F(q_j, P_j, t, \varepsilon)$, $Q_i = \frac{\partial}{\partial P_i} F(q_j, P_j, t, \varepsilon)$ is applied to (5). The generating function is represented in the form of an expansion $F = q_i P_i + \varepsilon F_1(q_j, P_j, t) + \varepsilon^2 F_2(q_j, P_j, t) + \dots$. The expressions for η_{iqk} and η_{ipk} defined by (3) are then determined by successive approximation: $p_k = Q_k + \varepsilon \eta_{iqk} + \dots$, $p_k = P_k + \varepsilon \eta_{ipk} + \dots$. The relations

$$\eta_{1qk} = -\frac{\partial F_1}{\partial P_k}, \quad \eta_{1pk} = \frac{\partial F_1}{\partial Q_k}, \tag{7}$$
$$\eta_{2qk} = -\frac{\partial F_2}{\partial P_k} + \frac{\partial^2 F_1}{\partial P_k \partial Q_l} \frac{\partial F_1}{\partial P_l}, \quad \eta_{2pk} = \frac{\partial F_2}{\partial Q_k} - \frac{\partial^2 F_1}{\partial Q_k \partial Q_l} \frac{\partial F_1}{\partial P_l},$$

hold, where $F_k = F_k(Q_i, P_i, t)$. The expression

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$$\bar{\eta}_{1qk} = \bar{\eta}_{1pk} = 0, \quad \bar{\eta}_{2qk} = \overline{\frac{\partial f_{qk}}{\partial q_l} f_{ql}}, \quad \bar{\eta}_{2pk} = \overline{\frac{\partial f_{pk}}{\partial q_l} f_{ql}}. \tag{8}$$

is obtained under the assumption that the F_k are periodic functions of time, so that $\bar{F}_k = 0$. In order to establish symmetry, $\bar{\eta}_{1qk}$ and $\bar{\eta}_{1pk}$ are chosen in the form

$$\bar{\eta}_{1qk} = \bar{\eta}_{1pk} = 0, \quad \bar{\eta}_{2qk} = \frac{1}{2}\overline{f_l \frac{\partial f_{qk}}{\partial \xi_l}}, \quad \eta_{2pk} = \frac{1}{2}\overline{f_l \frac{\partial f_{pk}}{\partial \xi_l}}. \tag{8'}$$

Thus, Eq. (6) in conformance with (5) and (8'), may be obtained from approximative equations in the canonical form with "averaged" Hamiltonian at an accuracy of up to terms of the order of ε^2:

APPROVED FOR RELEASE: 08/25/2000 CIA-RDP86-00513R001652310019-3"

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$$\mathcal{H} = \overline{\Pi} + \frac{\varepsilon}{2}\overline{\frac{\partial \Pi}{\partial \xi_i} f_i} + \frac{\varepsilon^2}{2}\left(\overline{\frac{\partial^2 \Pi}{\partial \xi_i \partial \xi_l} f_i f_l} + \overline{\frac{\partial \Pi}{\partial \xi_i}\frac{\partial f_i}{\partial \xi_l} f_l}\right) \quad (9).$$

Application of these averaged equations to the motion of charged particles in quickly variable electromagnetic fields is not restricted to nonrelativistic cases only; however, the explicite form is very complex. The Hamiltonian averaged over one coordinate is discussed in the third section of this paper. It is assumed that the Hamiltonian to be averaged in the sense of the first two sections of the paper) is periodic with respect to one coordinate (which need not necessarily be Cartesian). The last section deals with an application of the above calculations to the averaging of magnetic surfaces. There are 5 Soviet-bloc references.

PRESENTED: December 15, 1960, by A. L. Mints, Academician

SUBMITTED: December 6, 1960

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S/057/62/032/007/012/013
B104/B102

AUTHORS: Zuyeva, N. M., Morozov, A. I., and Solov'yev, L. S.

TITLE: Existence of magnetic surfaces of a periodic magnetic field having large longitudinal components, accurate to terms of the 4th order

PERIODICAL: Zhurnal tekhnicheskoy fiziki, v. 32, no. 7, 1962, 897-899

/B

TEXT: Magnetic surfaces are shown to exist, in fourth approximation, in the general case of a periodic field which has large longitudinal component $H_{\parallel}$. Magnetic surfaces not found by numerical methods either occur in higher approximation, or their effects are exponentially small. The equations averaged according to N. N. Bogolyubov for the lines of force of a magnetic field have unique integrals when terms of the order $(H_{\perp}/H_{\parallel})^4$ are taken into account.

SUBMITTED: March 5, 1962

Card 1/1

SOLOV'YEV, L.S.

Stability of a cylindrical plasma stream in a magnetic field.
Dokl. AN SSSR 147 no.5:1071-1074 D '62. (MIRA 16:2)

1. Predstavleno akademikom M.A. Leontovichem.
(Plasma (Ionized gases)) (Magnetic fields)

MOROZOV, A.I.; SOLOV'YEV, L.S.

Geometry of the magnetic field. Vop. teor. plaz. no.2:3-91 '63.

Motion of charged particles in electromagnetic fields. Ibid.:177-261
(MIRA 17:2)

ACCESSION NR: AT4019714 S/3041/63/000/003/0245/0289

AUTHOR: Solov'yev, L. S.

TITLE: Symmetrical magnetohydrodynamic flows and helical waves in a round plasma cylinder

SOURCE: Voprosy* teorii plazmy*, no. 3, 1963, 245-289

TOPIC TAGS: plasma, plasma cylinder, cylindrical plasma jet, magnetohydrodynamic flow, axial symmetry, translational symmetry, helical symmetry, helical flow, helical wave, linear wave

ABSTRACT: The general flow of a compressible liquid having helical symmetry is considered. Although the expressions can be derived in terms of only two spatial variables, the usual cylindrical coordinates are employed in the analysis here, since the transformation to the new coordinates is not complicated. The equations for the axial and translational symmetry are obtained from the helical symmetry by

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ACCESSION NR: AT4019714

going to the limit as the pitch of the helix goes to zero and to infinity, respectively. The section headings are: Introduction. 1. Stationary helical flows. 2. Helical waves. 3. On the stability of a cylindrical plasma jet in a magnetic field. 4. Nonlinear long-wave axially-symmetrical oscillations of a plasma cylinder. 5. Nonlinear helical waves. 6. Linear waves in a compressible plasma jet. Appendix. Curvature and torsion of the coordinate line x_3 in the case when $\partial g_{ik}/\partial x_3 = 0$. Literature. Orig. art. has: 173 formulas and 6 figures.

ASSOCIATION: Institut elektroniki, avtomatiki i telemekhaniki AN GruzSSR (Institute of Electronics, Automation, and Telemechanics, AN GruzSSR)

SUBMITTED: 00 DATE ACQ: 12Mar64 ENCL: 00

SUB CODE: PH NR REF SOV: 016 OTHER: 009

Card 2/2

DEM'YANENKO, D.M.; KOROZA, V.I.; RODA, A.A.; SOLOV'YEV, L.S.

Applicability of analog computers for calculating electron trajectories in linear accelerators. Uskoriteli no.5:91-95 '63. (MIRA 17:4)

APPROVED FOR RELEASE: 08/25/2000 CIA-RDP86-00513R001652310019-3"

MOROZOV, A.I.; SOLOV'YEV, L.S.

Typical structure of a toroidal magnetic field. Zhur. eksp. i teor. fiz. 45 no.4:955-959 O '63. (MIRA 16:11)

S/020/63/149/003/008/028
B112/B180

AUTHORS: Morozov, A. I., Solov'yev, L. S.

TITLE: Symmetric magnetohydrodynamic flows

PERIODICAL: Akademiya nauk SSSR. Doklady, v. 149, no. 3, 1963, 550 - 553

TEXT: For the stream functions ψ_0, ψ, I_0, I which are defined by

$$r\begin{pmatrix} v_r \\ H_r \end{pmatrix} = \begin{pmatrix} \frac{1}{\rho}\frac{\partial\psi_0}{\partial\theta} \\ \frac{\partial\psi}{\partial\theta} \end{pmatrix}, \quad \alpha r\begin{pmatrix} v_z \\ H_z \end{pmatrix} - \begin{pmatrix} v_\varphi \\ H_\varphi \end{pmatrix} = \begin{pmatrix} \frac{1}{\rho}\frac{\partial\psi_0}{\partial r} \\ \frac{\partial\psi}{\partial r} \end{pmatrix},$$
$$r\begin{pmatrix} I_{0r} \\ I_r \end{pmatrix} = \begin{pmatrix} \frac{\partial I_0}{\partial\theta} \\ \frac{\partial I}{\partial\theta} \end{pmatrix}, \quad \alpha r\begin{pmatrix} I_{0z} \\ I_z \end{pmatrix} - \begin{pmatrix} I_{0\varphi} \\ I_\varphi \end{pmatrix} = \begin{pmatrix} \frac{\partial I_0}{\partial r} \\ \frac{\partial I}{\partial r} \end{pmatrix}, \tag{6}$$

the system of equations

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Symmetric magnetohydrodynamic flows

$$\frac{s}{\rho}\Delta^{*}\xi+\frac{1}{2\beta\rho}\frac{\partial s}{\partial\xi}(\nabla\xi)^{2}-\frac{\psi_0'^{2}}{\beta\rho^{2}}(\nabla\rho\nabla\xi)+\frac{1}{2\beta\rho}\frac{\partial}{\partial\xi}\frac{A^{2}}{s}+ \tag{10}$$

$$+\frac{\beta}{2}\frac{\partial}{\partial\xi}\frac{B^{2}}{s}+\frac{\partial}{\partial\xi}\frac{AB\psi_0'}{\rho s\psi'}-\frac{2\alpha A}{\beta^{2}\rho}-U'=0;$$

$$W+\frac{v^{2}}{2}+\Phi+\frac{\beta B^{2}}{s}+\frac{AB\psi_0'}{\rho s\psi'}=U,\quad s\equiv\frac{\psi_0'^{2}}{\rho}-\psi'^{2}; \tag{11}$$

$$r\begin{pmatrix}v_r\\ H_r\end{pmatrix}=\begin{pmatrix}\psi_0'/\rho\\ \psi'\end{pmatrix}\frac{\partial\xi}{\partial\theta},\quad \alpha r\begin{pmatrix}v_z\\ H_z\end{pmatrix}-\begin{pmatrix}v_\varphi\\ H_\varphi\end{pmatrix}=\begin{pmatrix}\psi_0'/\rho\\ \psi'\end{pmatrix}\frac{\partial\xi}{\partial r},$$

$$\begin{pmatrix}v_z\\ H_z\end{pmatrix}+\alpha r\begin{pmatrix}v_\varphi\\ H_\varphi\end{pmatrix}=\frac{A}{s}\begin{pmatrix}\psi_0'/\rho\\ \psi'\end{pmatrix}+\frac{\beta B}{s}\begin{pmatrix}\psi'\\ \psi_0'\end{pmatrix}, \tag{12}$$

where $\Delta^{*}=\frac{1}{r}\frac{\partial}{\partial r}\frac{r}{\beta}\frac{\partial}{\partial r}+\frac{1}{r^{2}}\frac{\partial^{2}}{\partial\vartheta^{2}}$, is derived. The equations (10) - (12) describe the stationary flow of an ideal conductive compressible fluid in a magnetic field with helical symmetry. A and B are arbitrary functions of ξ. Examples of plane and axially symmetric flows are considered.

PRESENTED: October 27, 1962, by M. A. Leontovich, Academician

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S/020/63/149/003/008/028
B112/B180

Symmetric magnetohydrodynamic flows

SUBMITTED: October 11, 1962

Card 3/3

SOLOV'YEV, L.S.

Hydromagnetic stability of a rotating plasma. Dokl. AN SSSR 153 no.5:1048-1051 D '63. (MIRA 17:1)

1. Predstavleno akademikom M.A. Leontovichem.

L 41497-65 EWT(1)/EWP(m)/EPA(sp)-2/EWG(v)/EPR/EPA(w)-2/T-2/EWA(m)-2 Pab-10/ Pd-1/Pe-5/Ps-4/Pi-4 IJP(c)

ACCESSION NR: AP5009269 S/0040/64/028/006/0987/0995

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41
B

AUTHORS: Alekseyeva, L. M. (Moscow); Solov'yev, L. S. (Moscow)

TITLE: Current eddies and critical surfaces in magnetohydrodynamic flow

SOURCE: Prikladnaya matematika i mekhanika, v. 28, no. 6, 1964, 987-995

TOPIC TAGS: MHD flow, ideal fluid, plasma flow, steady flow equation, propagating wave, sonic line, stability criterion, magnetic pressure

ABSTRACT: The steady-state axisymmetric flow of an ideal conducting plasma across an azimuthal magnetic field H is studied analytically. The purpose is to investigate singular points on the family of current curves rH_φ = const and to calculate the form of the critical curve where v becomes equal to the propagation speed $c_s = \sqrt{c_T^2 + H_\varphi^2/4\pi\rho}$. The flow velocity is assumed to have two components v_r and v_z and, physically, the problem corresponds to the flow between two electrodes (see Fig. 1 on the Enclosure). It is assumed that the magnetic pressure is small compared to the gas pressure $\beta \equiv 8\pi p H^{-2} \gg 1$ and that the flow changes slowly along the z-axis. The governing equations then become $\frac{\partial}{\partial r}\frac{1}{\rho r}\frac{\partial \xi}{\partial r} = 0$, $W(\rho) + \frac{1}{2}\left(\frac{1}{\rho r}\frac{\partial \xi}{\partial r}\right)^2 = U$ and $I/\rho r^2 = B(\xi)$, $(I \equiv rH_\varphi/\sqrt{4\pi})$. Taking the r and z derivatives of the current curve

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$I(r,z)$ = const, it is shown that the singular points of this family of curves lie on the curve OO' (see Fig. 1). Taking the second derivatives of I, it is found that if the singular point on OO' lies below $r_c = 0.92R$, $V_c = 0.22u$, the curve is of the elliptic type, whereas if above these points the curve is hyperbolic. Furthermore, assuming U = const and the parameter $B(\xi)$ variable, the governing equations are written for both weak and strong magnetic fields $\frac{\partial}{\partial r}\frac{1}{\rho r}\frac{\partial \xi}{\partial r} + \frac{\partial}{\partial z}\frac{1}{\rho r}\frac{\partial \xi}{\partial z} + \frac{\rho^2 r^2}{2}\frac{dB^2}{d\xi} = 0,$ $W(\rho) + \frac{v^2}{2} + \rho r^2 B^2 = U$ and to a first approximation (order ε, $V_{1z} = 0$, b = const) the sonic surface is found to be planar, or $V^2(z) = 1/3\, u^2$. Correcting these results to order V, the curves of Fig. 2 are obtained (see Fig. 2 on the Enclosure) where OA corresponds to the negligible terms $(V^1)^2$ and OB shows the sonic curve for weak and strong fields where B^2 or W are neglected. The stability of the flow is investigated up to order ε. It is shown that for stability relative to axisymmetric perturbations the derivative of H^2/r^2 must be negative, and for helical stability, $(rH^2)'$ should be negative. "The authors are grateful to A. I. Morozov and K. V. Brushlinskiy for their valuable advice." Orig. art. has: 5 figures and 50 equations.

ASSOCIATION: none

SUBMITTED: 25 MAR 64

ACCESSION NR: AP4020569 S/0057/64/034/003/0429/0443

AUTHOR: Morozov, A. I.; Solov'yev, L. S.

TITLE: Axially symmetric steady flow of a plasma in an azimuthal magnetic field

SOURCE: Zhurnal tekhnicheskoy fiziki, v.34, no.3, 1964, 429-443

TOPIC TAGS: plasma, plasma flow, plasma ~~xxxxxxx~~ accelerator, adiabatic plasma flow, magnetohydrodynamics, steady magneto hydrodynamic flow

ABSTRACT: The steady isentropic flow in the annular space between two coaxial surfaces of revolution of a perfectly conducting compressible fluid in the presence of an azimuthal magnetic field is discussed in some detail. The calculations were undertaken because of possible applications to plasma acceleration. The magnetohydrodynamic equations are specialized to the case of isentropic flow with axial symmetry in which the radial and longitudinal components of the magnetic field and the azimuthal component of the velocity vanish. The resulting equations are discussed in two limiting cases: 1) the width of the annular channel is small compared with its radius, although both the width and the radius may be functions of the longitudinal coordinate z; 2) all quantities are slowly varying functions of z. In case 1)

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ACCESSION NR: AP4020569

it is possible to solve the problem for arbitrary channel shape. The solutions in which either the hydrodynamic or the magnetic pressure is small compared with the other are discussed in more detail. It is found that under some conditions the current may reverse and the magnetic field may act locally to decelerate the fluid. In case 2) the simplified equations are still nonlinear. Their solution is formulated as a Cauchy problem: one boundary of the channel is specified, together with the flow rate along it, and the other boundary is obtained as part of the solution. A number of solutions are obtained for the two limiting cases of a cold plasma, and of "isomagnetic flow" (the magnetic field proportional to the product of the fluid density and the distance from the axis). The shape of the "critical surface" on which the flow velocity is equal to the velocity of magneto-acoustic waves is discussed. Orig.art.has: 94 formulas and 5 figures.

ASSOCIATION: none

SUBMITTED: 01Mar63 DATE ACQ: 31Mar64 ENCL: 00

SUB CODE: PH NR REF SOV: 004 OTHER: 001

Card 2/2

S/0057/64/034/007/1141/1153

ACCESSION NR: AP4041988

AUTHOR: Morozov, A. I.; Solov'yev, L. S.

TITLE: Plane flow of a perfectly conducting compressible fluid with the Hall effect taken into account

SOURCE: Zhurnal tekhnicheskoy fiziki, v.34, no.7, 1964, 1141-1153

TOPIC TAGS: plasma, magnetohydrodynamics, Hall effect, plane parallel stream, steady flow

ABSTRACT: The magnetohydrodynamics equations for the steady flow of a perfectly conducting plasma are modified to take account of the Hall effect, and some consequences of the modified equations are derived. The modification of the magnetohydrodynamic equations consists in replacing the usual equation $\mathrm{rot}[\mathbf{v}, \mathbf{H}]=0$ by

$$\mathbf{E}+\frac{1}{c}[\mathbf{v}, \mathbf{H}]-\frac{1}{enc}[\mathbf{j}, \mathbf{H}]=0,$$

and introducing the equation

$$\mathbf{v}_e=\mathbf{v}-\frac{\mathbf{j}}{en};$$

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ACCESSION NR: AP4041988

for the current j. Here v_e is the electron velocity and v is the ion velocity. In the remaining magnetohydrodynamic equations the velocity is assumed to be that of the ions; thus, the electron pressure and the inertial forces of the electrons are neglected. Two stream functions are introduced (one for the ions and one for the electrons), and the conservation laws are derived. The plane flow in a channel bounded by cylindrical walls of arbitrary shape is discussed in some detail, and solutions are obtained for a narrow channel and for a channel with slowly varying section. The walls of the channel are regarded as electrodes through which current enters and leaves the plasma; the flow is thus of the type that occurs in a magnetohydrodynamic accelerator or pump. In such a system the Hall emf at the wall of the channel is tangent to the wall; the conductive wall will thus short circuit the Hall emf and a peculiar Hall-effect boundary layer will develop. This boundary layer is not discussed in detail. It is assumed that the boundary layer can be avoided by employing slotted electrodes. Orig.art.has: 98 formulas and 4 figures.

ASSOCIATION: none

SUBMITTED: 25Jun63 ATD PRESS: 3082 ENCL: 00

SUB CODE: ME,EM NR REF SOV: 002 OTHER:000

Card 2/2

L 8638-c; EWI(1)/EWP(m)/EWG(k)/EPA(sp)-2/EWG(v)/EPR/EPA(w)-2/EEC(t)/T-2/ EEC(b)-2/EWA(m)-2 Pz-6/Po-4/Pd-4/Pab-24/Pe-5/Ps-4/Pi-4 IJP(c)/RAEM(a)/ BSD/AEDC(a)/ESD(gs)/RAEM(c)/AFWL/SSD/ASD(a)-5/AFETR/ASD(d)/ASD(f)-2/AEDC(b)/ ASD(p)-3/ESD(t) WW/AT

ACCESSION NR: AP4041989 S/0057/64/034/007/1154/1169

AUTHOR: Morozov, A. I.; Solov'yev, L. S. B

TITLE: Acceleration of a rotating plasma in axially symmetric channels

SOURCE: Zhurnal tekhnicheskoy fiziki, v. 34, no. 7, 1964, 1154-1169

TOPIC TAGS: plasma, magnetohydrodynamics, plasma acceleration, plasma rotation

ABSTRACT: In this paper, earlier theoretical work of the authors (DAN SSSR, 149, 3, 1963; ZhTF 34, 3, 429, 1964) concerning the magnetohydrodynamic acceleration of a perfectly conducting plasma in an axially symmetric channel of annular cross section is extended to include rotation of a plasma and the presence of a longitudinal magnetic field. The magnetohydrodynamic equations are taken from the earlier work in a form suitable for axially symmetric calculations, and their integrals are discussed. The flow in narrow axially symmetric channels is then discussed. The flow in narrow axially symmetric channels is then discussed in detail. After the general integrals and the appropriate form of the Hugoniot equation are derived, flow with infinitely small initial velocity is discussed separately for the two cases that the radius of plasma (of infinitesimal but variable

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L 8638-65
ACCESSION NR: AP4041989

section) is or is not constant. The velocity of flow cannot pass continuously through the local signal velocity; the three possible types of continuous flow (flow velocity always greater than, equal to, or less than the local signal velocity) are discussed separately. In the final section the authors treat the flow of a cold plasma in a channel which need not be narrow, but in which the radii of the walls are slowly varying functions of the axial coordinate. Orig. art. has: 98 formulas and 6 figures.

ASSOCIATION: none

SUBMITTED: 18Jul63 ENCL: 00 SUB CODE: ME, EM

NO REF SOV: 005 OTHER: 000

Card 2/2

L 15062-65 EWT(d)/EWT(1)/EWG(k)/EPA(sp)-2/EEC-4/EPA(w)-2/EEC(t)/T/EEC(b)-2/
EED-2/EWA(m)-2/EWP(1) Pg-4/Pi-4/Pk-4/Po-4/Pq-4/Pz-6/Pab-10 IJP(c)/AFWL/SSD(b)/
ASD(a)-5/AEDC(b)/SSD/BSD/ASD(p)-3/AFETR/RAEM(a)/ESD(gs)/ESD(t) GG/AT/BB
S/0057/64/034/009/1566/1575

ACCESSION NR: AP4045265

AUTHOR: Morozov, A. I.; Solov'yev, L. S.

TITLE: Cybernetic control of plasma instabilities 21

16

SOURCE: Zhurnal tekhnicheskoy fiziki, v.34, no.9, 1964, 1566-1575

TOPIC TAGS: plasma instability, plasma stability, cybernetic system

ABSTRACT: It is proposed to suppress the development of certain instabilities in a plasma by injecting currents or applying local corrective magnetic fields of strengths and at locations determined by the developing instability itself. The proposal is illustrated by a discussion of the flute instability of a plasma cylinder confined in a magnetic field between magnetic mirrors. A number of probes would be disposed azimuthally about the plasma cylinder. Should an excrescence begin to develop, the nearest probe would sense this and the signal from this probe would cause application of an additional magnetic field at the appropriate position, thereby increasing the local magnetic pressure and driving the excrescence back into the body of the plasma. Alternatively, the signal from the probe could cause an azimuthal current to be injected into the plasma through electrodes on either side of the ex-

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L 15062-65
ACCESSION NR: AP4045265

5

crescence. It is estimated that for a 2 m long 60 cm diameter deuterium plasma cylinder in a 10^4 Oe magnetic field, having a particle density of 10^{13} cm^{-3} and thermal velocities of 10^8 cm/sec, corrective currents of the order of 30 A or corrective magnetic fields of the order of 50 Oe would be required. The nature of the feedback required to achieve stability is discussed in some detail for the simply Taylor instability of a plasma layer in magnetic and gravitational fields and for several instabilities of plasma cylinders, including constrictions, the helical instability in the presence of a longitudinal current, and the flute instability of a rotating filament. It is concluded that stability can be achieved in all these cases, but that the feedback signal must provide information concerning not only the present magnitude of the developing instability, but also concerning its rate of growth. "The authors express their gratitude to Academicians L.A.Artsimovich and M.A.Leontovich for their interest in the present work, and also to M.S.Ioffe, Ye.I.Dobrokhotov and N.N.Semashko for valuable discussions." Orig.art.has: 56 formulas and 7 figures.

ASSOCIATION: none

SUBMITTED: 13Nov63 ENCL: 00

SUB CODE: ME NR REF SOV: 005 OTHER: 001

2/2

L 27901-65 EWT(1)/EPA(sp)-2/EWP(m)/EWA(d)/EWG(v)/T-2/EPA(w)-2/EPR/EWA(m)-2
Pd-1/Pab-10/Pe-5/Ps-4/Pi-4 IJP(c)
ACCESSION NR: AP4012080 S/0020/64/154/002/0306/0309 67

AUTHOR: Morozov, A. I.; Solov'yev, L. S. B

TITLE: Symmetric flows of conducting fluid across a magnetic field

SOURCE: AN SSSR. Doklady*, v. 154, no. 2, 1964, 306-309

TOPIC TAGS: magnetic hydrodynamics, conducting fluid, compressed fluid, fluid flow, fluid mechanics, magnetohydrodynamics, axially symmetric fluid flow, magnetic field

ABSTRACT: A two-dimensional and axially-symmetric flow of a compressed conductive fluid was examined. Authors assumed for simplicity that fluid is nonviscuous and non-heat conducting. Then the stationary flow is described by the following magnetohydrodynamic equations:

$$(1)\quad \rho(\mathbf{v}\nabla)\mathbf{v} = -\nabla p + [\mathbf{jH}],$$

$$(2)\quad \operatorname{div} \rho\mathbf{v} = 0, \quad \operatorname{div} \mathbf{H} = 0,$$

$$(3)\quad \operatorname{rot} \vec{\varepsilon} = 0, \quad \rho T \mathbf{v} \nabla S = \nu_m j^2,$$

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L 27901-65
ACCESSION NR: AP4012080

where $\vec{\varepsilon} \equiv \frac{c}{\sqrt{4\pi}} \mathbf{E} = \mathbf{v}_m \mathbf{j} - [\mathbf{vH}] = \nabla\Phi, \ \mathbf{j} \equiv \mathrm{rot}\, \mathbf{H}, \ \mathbf{v}_m = c^2/4\pi\sigma,$

ρ = density; p=pressure; ρ=conductivity; T=temperature; S=entropy; V=velocity; B= $\sqrt{4\pi}$; H=magnetic field; E= electrical field. The following system of equations was then derived for the examined axially-symmetric flow:

$$\mathrm{div}\, \mathbf{q} = 0, \quad \mathbf{q} = \rho \mathbf{v}\left(W + \frac{v^2}{2}\right) + [\vec{\varepsilon}\mathbf{H}], \tag{4}$$

$$dW = \frac{dp}{\rho} + T\, dS. \tag{5}$$

$$\begin{pmatrix} \rho v_z \\ I_z \end{pmatrix} = \frac{1}{r} \frac{\partial}{\partial r} \begin{pmatrix} \psi \\ I \end{pmatrix}, \quad \begin{pmatrix} \rho v_r \\ I_r \end{pmatrix} = -\frac{1}{r} \frac{\partial}{\partial z} \begin{pmatrix} \psi \\ I \end{pmatrix}. \tag{6}$$

$$\frac{1}{\rho r} \frac{\partial}{\partial r} \frac{1}{\rho r} \frac{\partial \psi}{\partial r} + \frac{1}{\rho r} \frac{\partial}{\partial z} \frac{1}{\rho r} \frac{\partial \psi}{\partial z} + I\Phi''(\psi) + T \frac{\nabla S \nabla \psi}{\rho^2 r^2 v^2} - U'(\psi) = 0, \tag{7a}$$

$$W + \frac{v^2}{2} + I\Phi'(\psi) = U(\psi), \tag{7б}$$

$$\frac{I}{\rho r^2} - \mathbf{v}_m \frac{\mathbf{v}\nabla I}{\rho r^2 v^2} = \Phi'(\psi), \tag{7в}$$

$$\rho T \mathbf{v} \nabla S = \frac{\mathbf{v}_m}{r^2} (\nabla I)^2. \tag{7г}$$

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L 27901-65
ACCESSION NR: AP4012080

Two-dimensional flows in a narrow channel are described by the system:

$$\rho v f = \alpha = \text{const}, \quad (8)$$

$$\frac{H}{\rho} - \frac{\nu_m}{\rho v}\frac{dH}{ds} = \beta = \text{const}, \quad (9)$$

$$W + \frac{v^2}{2} + \beta H = U = \text{const}, \quad (10)$$

$$\rho v T \frac{dS}{ds} = \nu_m \left(\frac{dH}{ds}\right)^2. \quad (11)$$

Orig. art. has: 30 equations.

ASSOCIATION: None

SUBMITTED: 23Jul63 ENCL: 00

SUB CODE: ME, EM NO REF SOV: 003 OTHER: 000

Card 3/3

L 12916-65 EWT(1)/EWG(k)/EPA(sp)-2/EPA(w)-2/EEC(t)/T/EEC(b)-2/EWA(m)-2 Pz-6/Po-4/ Pab-10/Pi-4 IJP(c)/AEDC(b)/AFWL/AFETR/ASD(a)-5/ASD(p)-3/SSD/RAEM(a)/ESD(gs)/ESD(t)/

ACCESSION NR: AP4047322 SSD(b) AT S/0020/64/158/004/0831/0834

AUTHORS: Morozov, A. I.; Solov'yev, L. S.

B

TITLE: Equilibrium of plasma pinch with helical perturbations

SOURCE: AN SSSR. Doklady*, v. 158, no. 4, 1964, 831-834

TOPIC TAGS: plasma pinch, plasma instability, plasma containment

ABSTRACT: It is shown that the appearance of singularities in the linearized equations for perturbations of toroidal plasma configurations is connected with a qualitative rearrangement of the structure of the magnetic surfaces, and that arbitrarily small static perturbations can lead to finite changes in plasma configurations and thus noticeably affect their stability. The configurations considered are: 1. Cylindrical magnetic surfaces with helical perturbations. 2. Equilibrium helical plasma configurations. 3. Force-free plasma configuration. The first case results in a wavy mag-

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L 12916-65
ACCESSION NR: AP4047322

0

netic-surface structure with the elliptic and hyperbolic singular points lying on circles. In the second case it is shown that, depending on the choice of the initial equilibrium configuration, the development of instability reduces to the formation of a stable filamentary plasma structure. In the case of a force-free plasma configuration it becomes possible to obtain the stability conditions for a plasma supported by an ideally conducting liner. This report was presented by M. A. Leontovich. Orig. art. has: 6 formulas and 1 figure.

ASSOCIATION: None

SUBMITTED: 14Apr64 ENCL: 00

SUB CODE: ME NR REF SOV: 007 OTHER: 001

Card 2/2

L 13954-66 EWT(1)/ETC(F)/EPF(n)-2/EWG(m) IJP(c) DM/AT

ACC NR: AP6001691 SOURCE CODE: UR/0089/65/019/005/0420/0423

36
B

AUTHOR: Morozov, A. I.; Solov'yev, L. S.

ORG: none

TITLE: Magnetic mirror trap with a field increasing in all directions

21,44,55

SOURCE: Atomnaya energiya, v. 19, no. 5, 1965, 420-423

TOPIC TAGS: magnetic mirror machine, magnetic trap, axial magnetic field

ABSTRACT: The authors investigage the topography of the stationary point of the square of a magnetic field. It is shown that only saddle points of B^2 may exist along the axis of an axisymmetric field; minima of B^2 cannot be found in a plane field; a minimum of B^2 cannot be found in an axisymmetric field in a point which is not on the axis if the field direction in that point coincides with the symmetry axis z. Consequently, axisymmetric traps with minimum field region can be designed by using an azimuthal field as a basis (e.g., in conjunction with a superposed quadrupole field) or a basic radial field such as proposed by J. Andreoletti (C. r. Acad. sci., Paris, 256, 1969, (1963)). Since such a field has a very simple configuration, the authors study the properties of such Andreoletti fields the field strength lines of which become concentrated when approaching the z axis. Several possible solutions are proposed for magnetic mirror traps with special pole pieces or appropriate surface currents. Orig. art. has: 26 formulas and 3 figures. UDC: 533.9

SUB CODE: 20/ SUBM DATE: 28Jan65/ ORIG REF: 002/ OTH REF: 003

Card 1/1

L 3376-66 EWT(1)/ETC/EPF(n)-2/EWG(m)/EPA(w)-2 IJP(c) AT

UR/0020/65/164/001/0080/0083

ACCESSION NR: AP5023363

44,55

AUTHORS: Morozov, A. I.; Solov'yev, L. S. 44,55

71

B

TITLE: A similarity parameter in theory of plasma flows 21,44,55

SOURCE: AN SSSR. Doklady, v. 164, no. 1, 1965, 80-83

TOPIC TAGS: similarity analysis, plasma flow, compressible flow, magnetic field, entropy, Hall effect

ABSTRACT: A similarity analysis is made of a two-fluid, fully ionized plasma flow under steady state conditions. A vector potential is defined for ions and electrons $n_e v_e = \mathrm{rot}\,\vec{\Psi}_e, \quad n_i v_i = \mathrm{rot}\,\vec{\Psi}_i.$

which, when combined with Maxwell's equation, yields

$$H = \frac{4\pi e}{c}(\vec{\Psi}_i - \vec{\Psi}_e) + H_0.$$

The similarity parameter for the flow is defined by

$$\xi = \frac{c\,|H - H_0|\,\mathrm{charact}}{4\pi\,|\vec{\Psi}_i|_{\mathrm{charact}}}.$$

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L 3376-66
ACCESSION NR: AP5023363

For the case of a flow in a coaxial channel of arbitrary cross section ξ becomes

$$\xi=\left|\frac{N_e-N_i}{N_i}\right|=\frac{I_p}{I_s}.$$

Because of the fact that ψ is a three-dimensional vector, one can construct three ξ parameters. In the absence of dissipation terms and for $m_e/M \to 0$, the magnetic field degenerates into an electron component where one can show that ξ takes on the physical meaning of a "charge exchange" parameter. Orig. art. has: 16 equations and 3 figures.

ASSOCIATION: none

SUBMITTED: 05Jan65 ENCL: 00 SUB CODE: ME

NO REF SOV: 003 OTHER: 001

Card 2/2

L 33012-66 EWT(1) IJP(c)

ACC NR: AP6015087 SOURCE CODE: UR/0020/66/168/001/1176/0079

60
B

AUTHOR: Solov'yev, L. S.

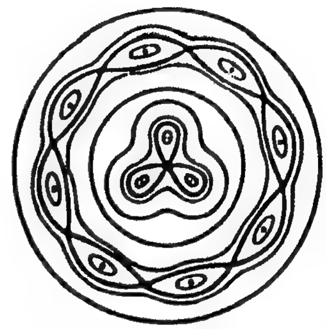
ORG: None

TITLE: Stability of magnetic surfaces

SOURCE: AN SSSR, Doklady, v. 168, no. 1, 1966, 76-79

TOPIC TAGS: magnetic property, surface property, coordinate system, structure stability, magnetic field

ABSTRACT: An approximate integral is found for equations of the lines of force of a magnetic field with a large longitudinal component in an arbitrary curvilinear coordinate system. The accuracy of the approximation depends on the selection of the curvilinear coordinates for the longitudinal and transverse components of the magnetic surfaces with respect to weak disturbances in the magnetic field. A right section showing the typical structure of stable magnetic surfaces is given in the figure. Orig. art. has: 1 figure, 13 formulas.



SUB CODE: 20/ SUBM DATE: 29Jul65/ ORIG REF: 005/ OTH REF: 002 UDC: 533.9

Card 1/1 pla

L 06977-67

ACC NR: AP6018349

separatrix are smaller than the distance to the magnetic axis. The feasibility of realising such a magnetic configuration is thus connected with the three-dimensional nature of the magnetic axis and with the ellipticity of the normal sections of the magnetic surfaces. Orig. art. has: 8 figures and 47 formulas.

SUB CODE: 20/ SUBM DATE: 14Aug65/ ORIG REF: 002/ OTH REF: 001

Card 2/2

EWT(1) EWT(m) AT

ACC NR: AP6031649 SOURCE CODE: UR/0020/66/170/001/0075/0078

AUTHOR: Solov'yev, L. S.; Shafranov, V. D.

ORG: none

TITLE: Contribution to the theory of equilibrium of a plasma in a toroidal magnetic trap

SOURCE: AN SSSR. Doklady, v. 170, no. 1, 1966, 75-78

TOPIC TAGS: magnetic trap, plasma stability, thermodynamic equilibrium, plasma magnetic field, perturbation theory

ABSTRACT: The purpose of the study was to ascertain the applicability of the boundary conditions (the Kruskal and Kulsrud conditions and the Newcomb condition) to the magnetic differential equation of a toroidal equilibrium plasma configuration. Solution of the differential equation for the toroidal magnetic surfaces in the linear approximation shows that the presence of resonant harmonics can either destroy the magnetic surfaces completely, or else under certain conditions lead only to a splitting of the resonant magnetic surfaces into a filamentary structure. Near resonance, only one harmonic of the perturbing field affects the stability of the surface. A method for solving the problem of plasma equilibrium in toroidal magnetic traps, based on the determination of the currents in the plasma and the associated disturbances of

Card 1/2 UDC: 533.9

the magnetic surfaces, is outlined. It is concluded that the formal solution of the perturbation-theory problem of equilibrium toroidal magnetic configurations contains small denominators analogous to the solutions of perturbation-theory equations in classical mechanics. The difficulties connected with the presence of the small denominators can be circumvented by normalizing (suitably choosing) the unperturbed solution on which the source function of the perturbation-theory equation depends. A concrete method of renormalization is proposed. This report was presented by Academician M. A. Leontovich 8 December 1965. Orig. art. has: 21 formulas.

SUB CODE: 20/ SUBM DATE: 29Oct65/ ORIG REF: 005/ OTH REF: 005

ACCESSION NR: AR4032171 S/0058/64/000/002/D029/D029

SOURCE: Ref. zh. Fiz., Abs. 2D223

AUTHORS: Reznikov, V. M.; Pilipchuk, Yu. S.; Solov'yev, L. S.

TITLE: Infrared spectra of dioxane-lignin

CITED SOURCE: Sb. Materialy* 1-y Nauchn. konferentsii Kompleksn. problemn. labor. Sibirsk. tekhnol. in-t. Krasnoyarsk, 1961, 36-42

TOPIC TAGS: dioxane, lignin, dioxane lignin, infrared spectrum, absorption spectrum, hydrogen bond, hydroxyl group

TRANSLATION: Infrared dioxane-lignin absorption spectra (3619--763 cm^{-1} region) were investigated in KBr dissolved in dioxane, suspended in mineral oil, and in the form of a film. A strong hydrogen bond is observed in the dioxane-lignin. It is established that in the lignin molecule, part of the hydroxyl groups remains free. It

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ACCESSION NR: AR4032171

is noted that the dioxane and the lignin are bound quite strongly in the film.

DATE ACQ: 31Mar64 SUB CODE: PH, CH ENCL: 00

Card 2/2

L 42871-66 EWT(1)/EWT(m)/EWP(j)/T IJP(c)
ACC NR: AR6017234 SOURCE CODE: UR/0058/65/000/012/D033/D033

AUTHOR: Korshunov, A. V.; Solov'yev, L. S.

60
B

ORG: none

21

TITLE: Infrared absorption spectra of paradihalogen-substituted benzene in various states of aggregation

SOURCE: Ref. zh. Fizika, Abs. 12D270

REF SOURCE: Tr. Komis. po spektroskopii. AN SSSR, t. 3. vyp. 1, 1964, 588-594

TOPIC TAGS: IR spectrum, absorption spectrum, benzene, liquid nitrogen, single crystal growth, halogen

ABSTRACT: The infrared absorption spectra have been obtained for paradihalogen-substituted benzene in various states of aggregation and at the temperature of liquid nitrogen. The method of growing fine single crystals has been worked out. Polariza-

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L 42871-66

ACC NR: AR6017234

O

tion analysis has been carried out for the infrared absorption spectrum of oriented single crystals of the paradihalogen-substituted benzene. Interpretation of bands has been carried out. It has been shown that the fission of certain bands conforms to theory. A. Davydov. [Translation of abstract] [NT]

SUB CODE: 07,20/ ~~SUBM DATE: none~~/ ~~ORIG REF: none~~/ ~~SOV REF: none~~/ ~~OTH REF: none~~/

Card 2/2 bdh

L 16714-65 EWT(m)/EPF(c)/EWP(j) Pc-4/Pr-4 ESD(t)/ESD(c)/ESD(gs)/SSD/AFWL/
ASD(a)-5/AFMD(t)/AFETR/RAEM(a) RM S/0058/64/000/010/D025/D025
ACCESSION NR: AR5000775

B

SOURCE: Ref. zh. Fizika, Abs. 10D192

AUTHORS: Korshunov, A. V.; Solov'yev, L. S.; Shufledovich, V. I.; Nekoshnova, N. S.

TITLE: Infrared absorption spectra of certain substances with hydrogen bonds in different aggregate states

CITED SOURCE: Tr. Sibirsk. tekhnol. in-ta, sb. 36, 1963, 10-17

TOPIC TAGS: ir absorption spectrum, hydrogen bond, band spectrum, polarization

TRANSLATION: Infrared absorption spectra of phenol, resorcin, guaiacol, and a naphthol in different aggregate states and at a temperature of liquid nitrogen are obtained. The polarization of the bands of the substances in the solid state was also investigated. It is found that in the liquid and particularly in the crystalline state the investigated substances have a few additional bands which are less intense than the fundamental bands

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L 16715-65
ACCESSION NR: AR5000773

was found to be 5.65×10^3 neutrons/mole-roentgen.

SUB CODE: NP ENCL: 00

Card 2/2

L 1300-66 EWT(m)/EPF(c)/EWP(j)/T RM

ACCESSION NR: AR5014391 UR/0058/65/000/004/D028/D028 54 53 B

SOURCE: Ref. zh. Fizika, Abs. 4D209

AUTHOR: Shufledovich, V. I.; Solov'yev, L. S.; Kuz'mina, Z. M.; Nekoshnova, N. S.; Sarapkin, P. S.; Korshunov, A. V.; Finkel'shteyn, A. F.

TITLE: Some spectral characteristics of the side chains in furane compounds

CITED SOURCE: Sb. Spektroskopiya. M., Nauka, 1964, 118-120

TOPIC TAGS: spectrographic analysis, Raman spectrum, IR spectrum, furane resin, aldehyde, conjugate bond system, alkyl radical

TRANSLATION: The authors studied the effect of the furane ring on the position of the stretching vibration bands of CH_3, C=O and C=C groups in the Raman and IR spectra of 6 furane derivatives. The frequencies of the fundamental bands in the spectra of these compounds are given in the 4050-216 cm^{-1} range. The position of symmetric and skew-symmetric stretching vibration bands in CH_3 groups in the spectra of furfruylidene acetone, sylvan and 1-(α-furyl)-butanone-3 is practically the same as the ordinary position of the bands for this group. The position of stretching

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L 1300-66
ACCESSION NR: AR5014391

vibration bands for C=O (1660-1685 cm^{-1} in the spectra of the two latter compounds) indicates that conjugation of this bond with the furane ring results in the same effects as conjugation with one double bond. Yu. Kissin.

SUB CODE: OC, OP ENCL: 00

mlr

Card 2/2

[illegible] V, [illegible]

[illegible] V, [illegible] -- "Therapeutic Properties of [illegible] Antib[illegible]." [illegible], [illegible]. (Dissertation for the Degree of Candidate in [illegible] Sciences).

[illegible]: Vechernyaya Moskva January-December [illegible]

SOLOV'YEV, L.Ya.

[Tax on services rendered; a practical manual] Nalog s netovarnykh operatsii; praktichekoe posobie. Moskva, Gosfinizdat, 1949. 31p. (Taxation) (MLRA 9:2)

35912

S/181/62/004/006/018/051
B125/B104

24.2600
26.2420

AUTHORS: Lider, K. F., and Solov'yev, L. Ye.

TITLE: The optical and photoelectrical properties of GeS and GeS_2

PERIODICAL: Fizika tverdogo tela, v. 4, no. 6, 1962, 1500-1502

TEXT: The authors studied the absorption spectra of GeS and GeS_2 single crystals and layers, and the spectral distribution of photoconductivity of a GeS crystal. The edge of the GeS_2 spectrum (just as that of MoO_3, BiO_3, V_2O_5, As_2S_3, PbO, HgI_2) has no structure; a photoconductive effect does not show up. A narrow, intense, polarized absorption line each was observed in the absorption spectrum of GeS at 77°K and at 4°K. The GeS and GeS_2 specimens (monocrystalline plates) were synthesized from Ge and S in a quartz ampoule and then annealed at a temperature near their melting point. The two absorption edges of the GeS crystals at room temperature are at ~7670 Å and 7260 Å. When the crystal is cooled to 77°K, the edges pass on to 7240 Å and 6900 Å. The long-wave edge

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S/181/62/004/006/018/051
B125/B104

The optical and...

corresponds to the polarization E∥a, the short-wave edge to E⊥c. a and c are the crystal axes lying in the plate plane. The absorption line ~7185 Å, observed in thin plates (d ~50 μ) and when the crystal was turned about the axis parallel to a, corresponds to a plane oscillator in the plane perpendicular to the c axis. At T = 4.2°K, the edge in the component E a is at ~7140 Å, and the line is at ~7110 Å. A broad luminescence band at 8000 Å appears in GeS crystals at 77°K. The blurred edge of the spectra of the GeS_2 crystals is displaced from 3500 Å at room temperature to 3300 Å at 77°K. The curve of the spectral distribution of photoconductivity taken in unpolarized light at 77.3°K has a maximum at ~7200 Å. The spectrum taken at 300°K is more intense, with a peak at ~7000 Å. The resistivity of GeS_2 specimens did not change on irradiation with concentrated undecomposed light from a mercury vapor lamp. Owing to the partial decomposition of the vacuum evaporation-coated GeS_2 layers (with formation of GeS), absorption occurs in the range of transparency of the GeS_2 crystals. The spectrum of a GeS_2 layer vapor-plated in an H_2S atmosphere is similar to the absorption spectrum of the GeS_2 crystals.

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The optical and...

S/181/62/004/006/016/051
B125/B104

The absorption edge may lie between 7200 Å and 3400 Å, according to the shares of GeS_2 and GeS in the mixture. There are 2 figures.

ASSOCIATION: Leningradskiy gosudarstvennyy universitet (Leningrad State University)

SUBMITTED: January 22, 1962

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S/020/62/146/003/009/019
B101/B144

AUTHORS: Gross, Ye. F., Corresponding Member AS USSR, Chang Kuang-yin, Solov'yev, L. Ye.

TITLE: Absorption spectrum in the light-blue and dark-blue spectral ranges and deformation effects in thin specimens of coprous oxide

PERIODICAL: Akademiya nauk SSSR. Doklady, v. 146, no. 3, 1962, 577-580

TEXT: Absorption and reflection spectra of Cu_2O specimens were taken at 4.2 and 77.3°K to check the assumption (Ref. 1: Fiz. tverd. tela, 4, 261, 827 (1962)) that the observed splitting of spectral lines of the Cu_2O single crystal is caused by deformation effects. In the absorption spectrum of a specimen 1 μ thick, the intense light-blue lines $\lambda_1^{(1b)'} = 4817$ Å, $\lambda_1^{(1b)''} = 4777$ Å, and the weak lines $\lambda_2^{(1b)'} = 4740$ Å and $\lambda_2^{(1b)''} = 4724$ Å were observed, which are interpreted as a splitting of

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B101/B144

Absorption spectrum in the ...

the lines $\lambda_1^{(lb)} = 4796$ Å and $\lambda_2^{(lb)} = 4733$ Å observed in the reflection spectrum. This was confirmed by the reflection spectrum of a wedge-shaped Cu_2O specimen, where the splitting increased with decreasing wedge thickness, whereas no splitting was observed for a Cu_2O lamina of 10-15 μ thickness. Likewise, the dark-blue lines $\lambda_1^{(db)} = 4569$ Å and $\lambda_2^{(db)} = 4505$ Å were split in the wedge-shaped specimen. With a 5 μ thick Cu_2O specimen, these lines were split into two perpendicularly polarized lines. As $\lambda_1^{(lb)}$ and $\lambda_1^{(db)}$ are more intense than $\lambda_2^{(lb)}$ and $\lambda_2^{(db)}$ it is concluded that they are allowed lines of hydrogen-like exciton series: light-blue series $\lambda_n^{(lb)} = 21220 - 368/n^2$ cm^{-1}, $n = 1, 2, \ldots$; dark-blue series $\lambda_n^{(db)} = 22302 - 415/n^2$ cm^{-1}, $n = 1, 2, \ldots$. A band diagram is suggested (Fig. 4) which, complementary to Ref. 1, is confirmed by new experimental data: Between 4.2 and 77.3°C, the differences between the temperature coefficients of the yellow and green series are equal to those between the light-blue and dark-blue series.

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Absorption spectrum in the ...

S/020/62/146/003/009/019
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If the dielectric constants of all series are set equal to each other, then $(R^{(db)} - R^{(lb)})/(R^{(g)} - R^{(y)}) = R^{(db)}R^{(lb)}/R^{(g)}R^{(y)}$ holds for the experimental values of the Rydberg constants $R^{(y)} = 780.7$, $R^{(g)} = 1200$, $R^{(lb)} = 368$, $R^{(db)} = 415\ cm^{-1}$. In all four exciton series, the deformation effect acts primarily on the conductivity band. Under the action of stress the conductivity sub-band Γ_6^+ is slightly shifted, and the Γ_{12}^- sub-band is split. There are 4 figures. The most important English-language references are: J. B. Grun, M. Sieskind, S. Nikitine, J. Phys. Chem. Solids, 21, 119 (1961); R. J. Elliott, Phys. Rev., 108, 1384 (1957); 124, 340 (1961).

SUBMITTED: June 18, 1962

Card 3/3

L 58916-65 EWT(m)/EPA(w)-2/EWA(m)-2 Pt-7 IJP(c) GS

ACCESSION NR: AT5007936 S/0000/64/000/000/0471/0474

AUTHOR: Belov, A. D.; Mur'n, B. P.; Solov'yev, L. Yu.; Kapchinskiy, I. M. 39 B+1

TITLE: Automatic regulation and measurement of the parameters of the high-frequency fields in a linear 100-Mev accelerator-injector 19

SOURCE: International Conference on High Energy Accelerators. Dubna, 1963. Trudy. Moscow, Atomizdat, 1964, 471-474

TOPIC TAGS: linear accelerator, high energy accelerator

ABSTRACT: In a linear 100-Mev proton accelerator-injector, the amplitude and phase of the high-frequency oscillations must be stabilized with an accuracy respectively ±2 and ±3°, according to the tolerances (I. M. Kapchinskiy et al., present conference, p. 462). In an accelerator one applies a system for the automatic regulation of the phase of the accelerating high-frequency voltage and the characteristic frequency of the resonator. The accepted measures for stabilizing the feed voltages in the generators permit a considerable decrease in the variation of the phase in the high-frequency accelerator channels. It is possible here to apply only electronic-mechanical automatic regulation systems, which eliminates slow phase departures in the high-frequency feed track and the thermal disorganization of the reso-

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ACCESSION NR: AT5007936

nator (B. P. Murin, NT-2160, Radiotekhnicheskiy institut AN SSSR. M. 1960). The present report discusses the general scheme of the high-frequency track and the electric circuit of the automatic phase regulation system in the accelerator channels. Selection of the carrier phases yields, for a given accuracy of the automatic phase regulation system, optimum stability of the fixed difference of phases among the resonators. The present report discusses the expanded block diagram of the automatic phase regulation system for the second channel. In the bridge-type phase transducer, a signal from the resonator is in phase with the high-frequency carrier phase oscillations. In case of the presence of a phase error, a pulse signal will appear at the output of the phase transducer. The information entering the regulation system is free of transitional processes, since the phase transducer has a stroboscope circuit which permits limiting the information during the course of the last 30 microseconds after establishment of the high-frequency field in the resonator. In the circuit for processing the error signal, the information is held up to the following track, and after arrival of the second error signal of the same sign from preceding tracks the circuit transforms it into a controlling voltage, which acts upon the electric motors through magnetic amplifiers. Each resonator has two plates for correcting the distribution of the accelerating field along the resonator axis. The report discusses the main parameters of the automatic phase

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ACCESSION NR: AT5007936

regulation system and the principal system errors and their propagation and a system of automatic control for the fixed phase relations among the resonators. Amplitude transducers are employed for controlling the amplitude of the high-frequency field. The transducers are connected with loops in the resonators with the aid of a coaxial 75-ohm cable, in which a traveling-wave state has been established. The transducer transforms the high-frequency pulse into a video pulse, whose amplitude is measured by a compensation method with manual setting of the carrier voltage. Accuracy of measurement is 0.5%. Aperture of the first drift tube is 20 mm. The transverse acceptance of the linear accelerator has been computed to be about 0.8 cm·millirad for full aperture. The accelerator will deliver about 100 milliamperes. Pulse length will vary from 12 microseconds for one-revolution injection up to 40 microseconds for three. The repetition rate is 12 pulses per minute. Orig. art. has: 4 figures.

ASSOCIATION: Radiotekhnicheskiy institut AN SSSR (Radio Engineering Institute, AN SSSR)

SUBMITTED: 26May64 ENCL: 00 SUB CODE: EE, NP

NO REF SOV: 002 OTHER: 000

Card 3/3 dm

SOLOV'EV, M. [Solov'jov, M.]

Uniaxial trailers for the transport of containers. Transp delo 6 no.9/10:89 '54.

APPROVED FOR RELEASE: 08/25/2000 CIA-RDP86-00513R001652310019-3"

L 21442-66 EWT(d) BC
ACC NR: AP6003293 SOURCE CODE: UR/0209/66/000/001/0064/0065

AUTHOR: Solov'yev, M. (Engineer)

21
B

ORG: none

TITLE: How to check out base-altitude indicators

SOURCE: Aviatsiya kosmonavtika, no. 1, 1966, 64-65

TOPIC TAGS: altimeter, aircraft flight instrument, instrument calibration equipment

ABSTRACT: A portable instrument for checking low-altitude radio altimeters having light and audio base-altitude indicators is proposed. With this instrument the altitude indicators can be adjusted directly in the aircraft or in the laboratory. The instrument works on 115-v,

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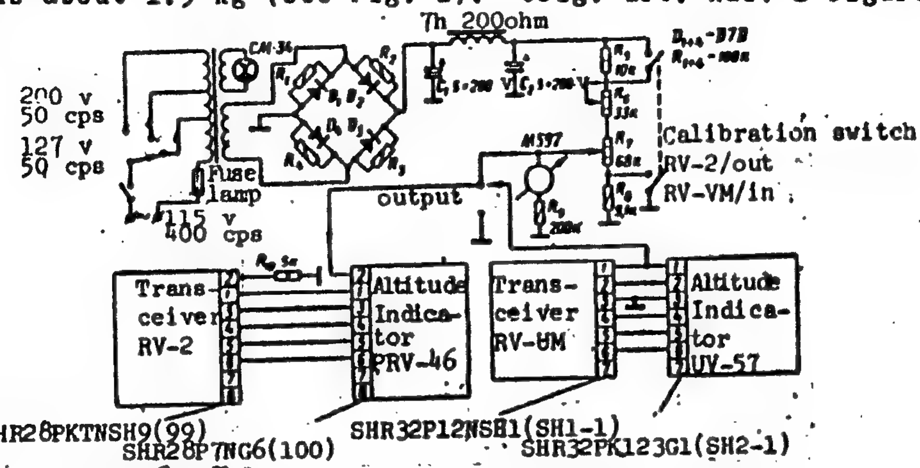
ACC NR: AP6003293

400-cps or 127/220-v, 50-cps current. With adapters and cable the device weighs about 1.5 kg (see Fig. 1). Orig. art. has: 1 figure.



Crossover for cali-
bration of SV-R RV-2

Crossover for cali-
bration of RV-UM

Fig. 1. Device for checking and calibrating altitude indicators

[WS]

SUB CODE: 01/ SUBM DATE: none/ ATD PRESS: 4221

Card 2/2

..L.V'YEV, M., inzhener.

Adopt more extensively the new methods for producing buckwheat groats. Muk.-elev.prom. 23 no.7:21-22 Jl '57. (MIRA 10:9)
(Buckwheat) (Grain milling)

SOLOV'YEV, M., inzh.

Machine for polishing hulled millet. Mukh.-elev. prom. 24 no.4: 18 Ap '58. (MIRA 11:5)

1. Glavnoye upravleniye mukomol'noy, krupyanoy i kombikormovoy promyshlennosti Ministerstva khleboproduktov RSFSR.
(Grain milling machinery)

SOLOV'YEV, M. , inzh.

Production of five grades of polished corn groats. Muk. elev. prom. 24 no.11:23-24 N '58. (MIRA 11:12)

1.Glavnoye upravleniye mukomol'noy, krupyanoy i kombikormovoy promyshlennosti Ministerstva khleboproduktov RSFSR.
(Corn milling)

SOLOV'YEV, M.

Machine for polishing groats. Muk.-elev.prom. 26 no.1:30-31 Ja '60. (MIRA 13:6)
(Grain-milling machinery)

NEZLOBIN, M.; KHABE, L.; SOLOV'YEV, M.

Recent developments in the technology of groats. Muk.-elev. prom. 29 no.9:20-22 S '63. (MIRA 17:1)

1. Proizvodstvenno-tekhnicheskoye upravleniye Gosudarstvennogo komiteta zagotovok (for Nezlobin, Khabe).
2. Vserossiyskoye ob"yedineniye khleboproduktov (for Solov'yev).